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USB SENSORS AS A NEW CHALLENGE FOR MEASUREMENT SYSTEMS

USB SENZORY JAKO NOVÁ PŘÍLEŽITOST PRO MĚŘICÍ SYSTÉMY

Abstract

New trend in area of industrial sensors there are availability of "smart sensors" with connection to PC or PDA computers. In the paper there are presented an experience with design and applications of measurement tasks by USB modules from firms Phidgets (Canada) and Futek (USA).These types of sensors are flexible, small form size, by USB bus electronics power supply and cover inexpensive the main measurement functions. By this way can be measured values as a temperature, force, pressure, displacement and rotation of object, vibration, angle or rotation with USB encoders, or RFID modules there are obtainable. On the Department CSI VS˘B-TU Ostrava there were solved the tasks with program connection support of 2 and 3 axis USB accelerometers by the program LabVIEW. In the next tasks were testing of properties and function possibilities of smart USB sensors temperature, force, linear and rotation displacement.

Abstrakt

K novým trendům v průmyslových senzorech patří dostupnost „smart USB senzorů" s připojením k PC nebo k PDA počítačům. V příspěvku jsou prezentovány zkušenosti z návrhu a aplikace měřicích úloh pomocí USB modulů od firmy Phidgets (Kanada) a Futek (USA).Tyto typy senzorů jsou flexibilní, miniaturní, jsou napájené přímo přes sběrnici USB, a pokrývají levně řadu měřicích funkcí. Mohou tak být měřeny veličiny jako teplota, síla, tlak, posunutí a natočení objektu, vibrace, úhel nebo otáčky pomocí USB enkodérů a jsou dostupné i RFID moduly. Na katedře ATŘ VŠB-TUO byly řešeny úlohy s programovou obsluhou připojení 2 a 3 osých USB akcelerometrů pomocí programu LabVIEW. Dále byly řešeny experimentální úlohy s testováním vlastností a funkčních možností inteligentních USB senzorů teploty, síly, tlaku, lineárního as rotačního posunutí a natočení.

1 USB SENSORS – PROPERTIES AND POTENTIAL

In last three years was turn up information's and now also first samples of functionally interesting sensors. These sensors are connect to the controller by serial bus USB. That is in quickly function develop in light of communication speed, possibilities supply of connected modules etc. Production devices for industry automa-tization are relatively conservative line and weighty standard for these devices is high safety. It is logical with systems that control exacting and expensive technology. Standard computer interface as well as classic serial port RS232 is at the present time inadequate in light of signal rate and don't provide enough comfort during working with connecting devices (detection of device, installation of drivers, supply). Mostly these deficiencies are eliminated

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by USB interface that largely replaced old computer interface. Basic characteristic of four-wire serial interface USB are support Plug&Play technology, data rate to 480 Mb/s and possibility supply of device by USB bus (5 V, max. 500 mA). For communication between computer and device are used packets (token packet, data packet a handshake packet), data are transferring between so-called endpoints in form data stream or data messages. Communication is executed on base of requirement from host PC [MATOUŠEK, 2003], [USB, 2009].

USB sensors consist from oven transmitter, that transfer non-electric value (temperature, pressure, vibration) to output voltage and circuit, that makes it possible connecting this measuring chain to PC by USB bus. Measured signal has not to be better amplify, information's from sensors are possible modify, save and display by user created application. These applications is possible to program by many programming tools (for example VB6, VB.NET, C#.NET, C++, Java, LabVIEW, Python, etc.). From PC is often enabled set and read several parameters (serial number, sensitivity, range of sensors, properties servomotors).It was by complexity of sensor circuit. There is possible connect several sensors (is depends on type of interface) to one USB port. Except analog sensors is possible to USB connect digital outputs (LED diodes) or relay and servomotors. USB modules enable integrate more types same or other sensors to multisensors platform. For example, company FUTEK Engineers provides connecting to 127 sensors by USB more-input hubs that can arch over to 45 meters without expressive disturbance (Fig. 1). Biggest advantage is flexibility these multiplex connection during configuration measure or control work and easier identification and localization error by USB sensor [FUTEK, 2009], [JURÁNEK, 2009].

2 DESCRIPTION OF COMPONENTS BY COMPANIES PHIDGETS AND FUTEK

Many aspects of industrial applications have been considered to realize a suitable solution. Insulation problems and low-cost implementation have been tackled. Working prototypes of each network component have been defined and realized: USB host gateway, USB insulator, and USB hub. Several commercial USB devices can be used as sensors. Phidgets (Canada) produced a set of "plug and play" building blocks for low cost USB sensing and control from your PC.Standard equipment of PC and notebooks is USB port - as a serial communication interface. Company Phidgets (Canada) and Futek (USA) produce sensors as well actuators, which are possible connected to monitoring (control) system by their serial USB interface [SENSOR NODE, 2009], [DEPARI, & other, 2004], [SAPINSKI, 2008].

These devices can be connected to control system straight by USB port or USB HUB (hub with USB 2.0). Companies produce software support to these devices and their actual versions are free downloaded from internet pages by company Phidgets or Futek. Supported operating systems are Windows 2000/XP/Vista, Windows CE, Linux, etc. Company Phidgets produced sensors with library in environment Visual Basic 6. In this environment is possible create Active_X component, that support communication with sensors for example temperature. Components Active_X operate at full without virtual environment and they may exact algorithms as for example 3D graphic or manipulation with pictures. In laboratory of institute ATŘ VŠB-TUO was tested temperature sensors Precision temperature sensor (RTD) a PhidgetTemperatureSensor with thermocouple – type K (see Fig. 1, Fig. 2). Important module for connection of analogue modules with voltage output there is The PhidgetInterfaceKit 8/8/8, which provides 8 Analogue Inputs, 8 Digital Inputs with hardware noise filtering, 8 Digital Outputs.

The analogue inputs are used to measure continuous quantities, such as temperature, humidity, position, pressure, etc. Phidgets offers a wide variety of sensors that can be plugged directly into the board using the cable included with the sensor. The Digital Inputs have a Digital Input Hardware Filter to eliminate false triggering from electrical noise. They can be used to convey the state of devices such as push buttons, limit switches, relays, and logic levels. The Digital Outputs can be used to drive LEDs, solid state relays, transistors; in fact, anything that will accept a CMOS signal. They also can be used to control devices that accept a +5V control signal. With transistors and some

electronics experience, other devices can be controlled, such as lights, larger LEDs, relays [JURÁNEK, 2009], [PHIDGETS, 2008a, 2009b].

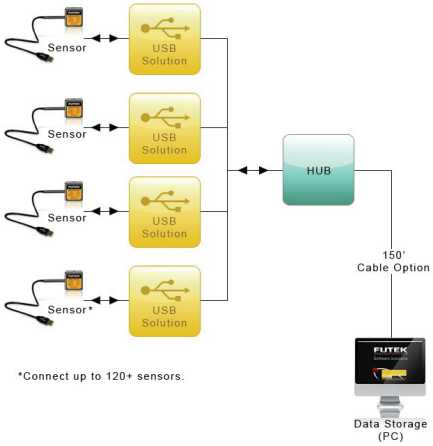


Fig. 1 Connection of multiplex group of USB modules FUTEK

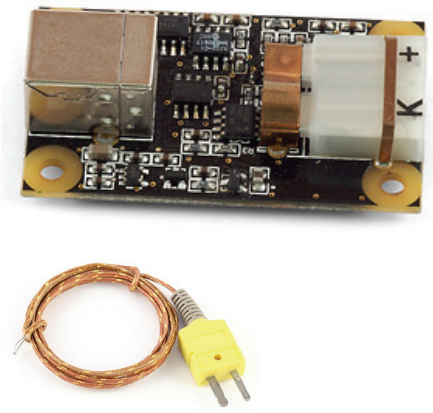


Fig.2 USB module – Phidget Temperature Sensor, thermocouple type - K

3 USB MODULE WITH THERMOCOUPLE

Thermocouple module sends to PC information about actual measurement temperature with sampling frequency 30 Hz, but with other sensor identification information (serial number, temperature range). On Fig. 3 we can see dynamical of USB thermocouple module [PHIDGETS, 2008a].

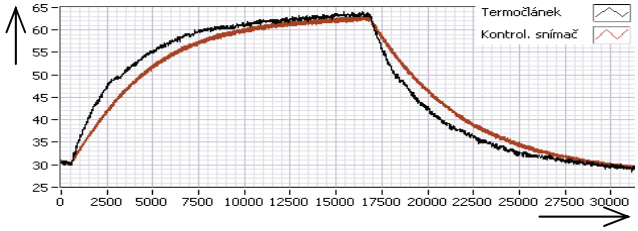


Fig. 3 USB module – PhidgetTemperatureSensor – comparing dynamic response of thermocouple K and precision temperature sensor Pt-100

Laboratory application work was realized in environment LabView and is to make to measure temperature assist in thermocouple and second module of Phidgets-resistance temperature sensor (Precision temperature sensor). While thermocouple K is connected to USB across own circuit and output data are in step of Celsius, resistant sensor RTD is connected by Phidgets interface and is necessary re-count output to unit of temperature. During presentation is possible displayed serial number of USB circuit for thermocouple connecting, range of sensor as well as his temperature. There are used tools for average, maximal and minimal temperature of thermocouple K. For eliminate noise is in application possible activate running average, when is computed arithmetically average for select number of samples. For user is easier pursue temperature on digital display and data can be continuously displayed in graph and on virtual thermometers (see Fig. 4).

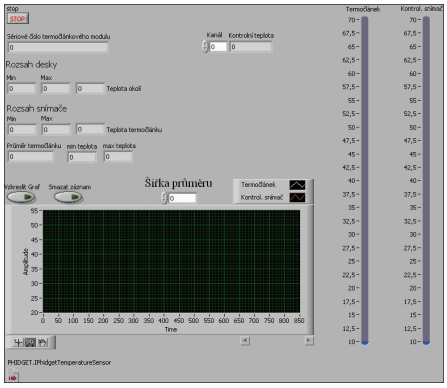


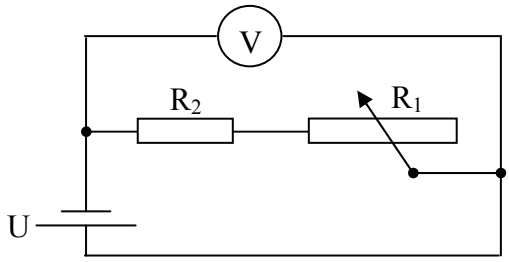
Fig. 4 Front panel task for temperature measuring by USB modules with LabVIEW support

Parameters of position sensor:
Range 0 mm to 60 mm
Output (PC) Number 0 to 1000
Current consumption 150 μA
Output resistant 10 kΩ
Supply voltage 3 V to 5,25 V (DC)

Fig. 5 Resistant position sensor [Phidgets, D]

4 SLIDING SENSOR OF POSITION

This simple sensor of position has range from 0 to 60 mm. This distance is on PC represented by numbers from 0 to 1000 (tested sensor – from 0 to 999). It applies to compute data (*SensorValue*), not computed data (*RawSensorValue*) from sensor are integer from 0 to 4092. Sensor is designed for compatibility with devices that work with voltage 3,3 V. It means, that can be connected to devices of other producers without modification. Sensor work on similar principle as well as potentiometer, change slider position evokes change sensor resistance [Phidgets, D]. Sensor is possible connect to PC across by the help of Phidgets Interfacekit. By Sensor testing was measured precise sensor range (shift slider) 60,5 mm. This range is limited on both endings. In minimum sensor irresponsive to deviation 1,5 mm (see Fig. 6). On the Fig. 7 we can see dependent of output from sensor on deviation during escalation and next reducing of deviation. Dependence is nearly linear. Values output on assigned distance are nearly same for escalation and reducing deviation. Difference between values output during escalation and reducing deviation is smaller than 1 mm (at average 0,35 mm). Distance was measured manually up 5 mm. Output from sensor was saved by application made in environment LabVIEW.



R_1 – Variable resistor (potentiometer)

R_2 – Added resistor

By change slider position (shift) causes change resistance R_1.

Fig. 6 Common scheme and description of resistant position sensor

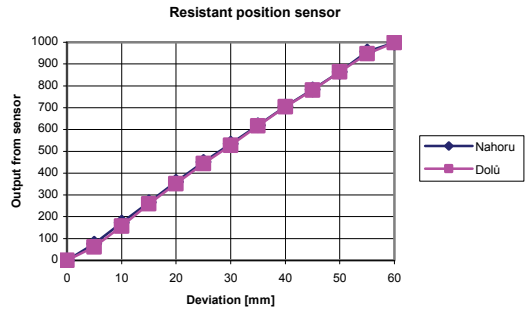
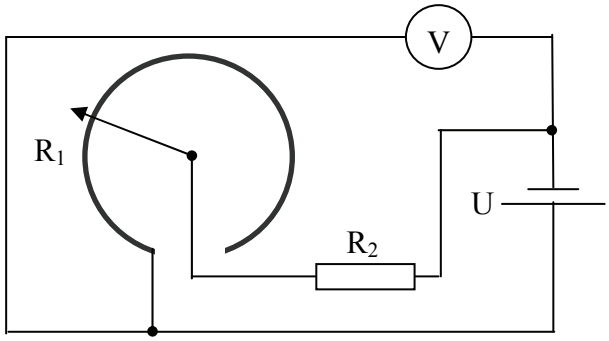


Fig. 7 Dependences output of resistant sensor on deviations

5 ROTATION USB SENSOR

As well as previous sensor, it is resistant sensor. This sensor is measure rotating (angle). This range is from 0° to 300°. Output is number from 0 to 1000 (in depended on deviance). Principe of this resistant USB sensor is similar as well as previous example. Change turning slider causes change

resistance of sensor (see Fig. 8). Sensor is possible connect to PC across by the help of Phidgets Interfacekit [Phidgets, 2008b].



R_1 – Variable resistor (potentiometer)
R_2 – Added resistor
By change slider position (turning) causes change resistance R_1.

Range	0° to 300°
Output (PC)	Number 0 to 1000
Current consumption	500 μA
Output resistant	10 kΩ
Supply voltage	3 V to 5,25 V (DC)

Fig. 8 Common scheme and description of resistant rotation sensor and his properties [Phidgets, C]

6 LIGHT SENSOR

This light sensor has smaller range than human eye, but it is more sensitivity to change luminosity. Humen eye has range nearly from 50 μlux to 100 klux, light sensor measure nearly from 1 lux do 1000 lux. Sensor can identify smaller light oscillation and higher frequency than eye. It means, that during measuring for example in office can be on output signal with period of light source (flour tube, monitor,…). This sensor is adapted for connecting to USB PC by Phidgets Interfacekit. As well as mostly this sensors, this sensor is compatible with devices for 3,3 V too (see Fig. 9 – 10).

After connecting sensor to PC for computed output of sensor to light intensity possible using computed *light intensity [lux] = (RawSensorValue / 4.095),* or using output straight *SensorValue*: *SensorValue = [lux]*.

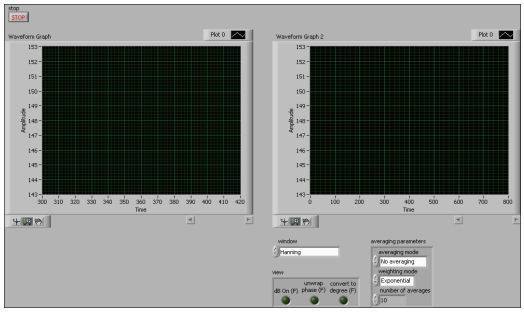


Fig. 9 Front panel task for light intensity measuring by USB module in LabVIEW

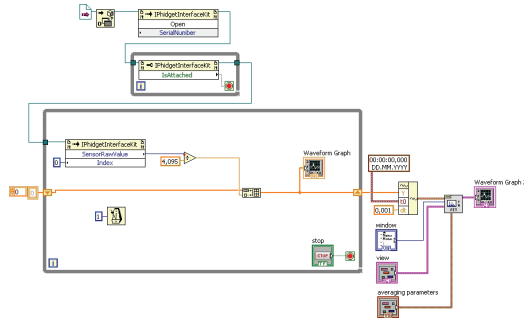


Fig. 10 Block schema for light intensity measurement in LabVIEW

7 CONCLUSION

USB sensors there are the latest in smart sensor technology with direct computer interface, providing an accurate and cost-effective water quality sampling solution. An integral USB connector offers a simple, hassle-free connection without meters, batteries, or power supplies and gets its power from the USB port, and data is displayed in real-time directly on the computer monitor.

When connected, the sensor's unique ID is automatically recognized, and the most recent calibration, factory calibration, and probe status are displayed. On Department of Control Systems and Instrumentation there were verified possibility using of new type USB sensors from company Phidgets. With program support SDCADA/MMI system Control Web 5 and LabVIEW was made some application exercises that enabling measurement and control temperature model with possibility saving and monitoring date.

Components and USB modules Phidgets offer includes different sensors connectable straight by USB bus or by special Interfacekit. They are fit to informative measurement of different physical values, many of them is possibility used to precision measure different values – temperature, pressure, rotation speed, RFID etc. In next experimental activity in intended to be expand choice of USB sensors any module company FUTEK and make-up combined multisensor statement with oven software application.

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